A DECISION MODEL FOR THE FORCE LEVEL REQUIREMENTS OF THE ARMY STRATEGIC OBJECTIVE PLAN

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THESIS

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ABSTRACT

A model of the ASOP decision process within the Office of the Deputy Chief of Staff for Military Operations is formulated. This decision deals with the aggregated force level estimates for the ASOP. The variables of the model are the informational sources which are utilized in forming the estimate for the ASOP. The Planning, Programming and Budgeting System requires annual submission of the Army's estimate of forces needed to meet strategic objectives. The background for the ASOP estimate is presented. A closer examination of the environment which prevails at ODCSOPS is then examined. The model is then described with a justification for selecting and quantifying the model's variable. A statistical technique was suggested to demonstrate possible insights which could be obtained from the model. The validity of the model is addressed in the concluding portion of the thesis.

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GLOSSARY

ACSFOR:	Assistant Chief of Staff for Force Development
ASOP:	Army Strategic Objective Plan
ATLAS:	Computerized theater level war game
CinC:	Commander-in-Chief
DCSOPS (ODCSOPS):	Office of the Deputy Chief of Staff for Military Operations
DFE:	Division force equivalent
DoD:	Department of Defense
FASTALS:	Computerized force structuring model
FEBA:	Forward edge of the battle area
FOREWON:	Automated force planning system
JCS:	Joint Chiefs of Staff
LOC:	Line of communication
OASD(SA):	Office of the Assistant Secretary of Defense (Systems Analysis)
OSD:	Office of the Secretary of Defense
PPBS:	Planning, programming and budgeting system
RAC:	Research Analysis Corporation
STAG:	Strategy Tactics Analysis Group
TCM:	Theater combat model

I. INTRODUCTION

This thesis proposes a decision model for the process which annually estimates the land forces needed to fulfill the Army's worldwide commitments. The model describes the interactions of relevant factors which influence the estimate of land forces in the Army's Strategic Objective Plan (ASOP). On the Army Staff, the Deputy Chief of Staff for Military Operations (DCSOPS) has the responsibility of preparing the force estimates for the ASOP, the Army's mid-range planning document in the annual Planning, Programming, and Budget System's (PPBS) cycles. Planning information is received from:

1) The President and National Security Council in terms of strategic guidance
2) The Department of Defense force planning agencies, chiefly AOSDSA
3) The Joint Chiefs of Staff (JCS)
4) The Office of the Secretary of Defense (OSD)
5) Intelligence agencies who provide threat analysis
6) Other Army Staff Sections and Commands

The scope of this thesis is limited to examining the aggregated force requirements expressed in Army division force equivalents[1] which are requested in the ASOP. The staff recommendation for the ASOP force

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[1]The division force equivalent (DFE) or average force size approximates 48,000 men, with roughly equal 16,000 men increments: the division itself; the initial supporting increment (ISI) required for the initial stages of combat; and the sustaining support increment (SSI) required for sustained combat beyond 60 days. The DFE is the basic unit of measurement for the decision model.

level decision which DCSOPS prepares for the Army's chain of command is the subject which this thesis examines. This recommendation will be referred to as the "ASOP estimate" throughout this presentation. In developing the decision model for the process that yields this estimate, a review of the background of the estimate and its environment is necessary. The approach taken is to place the ASOP in the framework of the defense planning effort and then examine how the ASOP estimate is used in establishing Army force levels. The current Army approach in determining the ASOP estimate is then contrasted with an alternate approach to force planning.

The proposed decision model describes the current procedures which DCSOPS utilizes in the estimation process. Using the decision model and evaluating the contributions of the variables in the model's equation, it is possible to reconstruct the ASOP estimate and determine the trends in the ASOP decision. For example, an increased reliance on automated force planning systems, such as FOREWON, could be identified using techniques such as regression analysis. If these trends are identified and the contributions of the variables quantified, the model would prove useful in justifying the proportion of planning effort, both in time and money, that should be affixed to each of the ASOP information sources. For example, if the model indicated a constant 70% contribution for FOREWON in the ASOP estimate, this would imply that at least a similar percentage of planning time and money should be devoted to improving and refining the FOREWON results. The validity of the model is addressed in the concluding chapter of this thesis. Although some of the material presented relates to previous approaches to the force planning problem, the present tense is used throughout the development of the thesis for clarity of presentation.

II. BACKGROUND

This section develops the general framework of defense management in which the ASOP is produced. The management system which is discussed is commonly called the PPBS. The PPBS's impact on Army force planning can be shown by the preparation of the ASOP and the corresponding analysis. A definition of the key Army planning activities precedes an explanation of the Army's role in the PPBS.

The United States Army continually plans for the future. One step in that planning is the determination of the required future size of the Army, given a statement of the contingent missions it may be called on to perform. The word "required" is a difficult word to define in the context of force planning. What is considered "required" by one planning agency may be on the "wish list" of another agency whose interpretation of national goals differs. This points out a need for defining the terms in the planning process.

According to Colonel John R. Brinkerhoff in his review of force planning in the Department of Defense[1] there are four force structures in the planning environment:

1. The Objective Force
2. The Approved Force
3. The Authorized Force
4. The Actual Force

Colonel Brinkerhoff calls on his seven year working level experience in the force planning field to explain the complexities of force planning by establishing "user oriented" definitions for the planning terms. This approach is appropriate for this discussion since the proposed decision model relates to the working level within DCSOPS.

The force structures are best defined by their relationship with the resources which comprise the force. The Objective Force is the set of desired resources. The Approved Force is the set of required resources to establish the envisioned force. The Authorized Force is the set of funded resources. The Actual Force is the set of presently existing resources. There is a definite difference between the Objective Force and the Approved Force. The Approved Force establishes the military resource level which, in the judgment of the Secretary of Defense, is necessary to assure that national objectives are met. The Objective Force is the product of the Joint Chiefs of Staff and the Services estimates of what force levels are necessary for the accomplishment of the national objectives.

The four forces are linked together by five force processes:

1. Analysis
2. Estimation
3. Development
4. Management
5. Employment

Their relationships are shown in Figure 1.

The scope of this thesis is restricted to examining the force estimation process. Force estimation is accomplished by the Office of the Secretary of Defense, the Joint Chiefs of Staff, and by each respective Service. The product of the Services and JCS effort is the objective force and is published annually in the Joint Strategic Objective Plan (JSOP). OSD estimates forces annually to establish a basis for reviewing the JCS and Services estimates. They establish a DoD position for requesting future force levels from Congress and the President. In

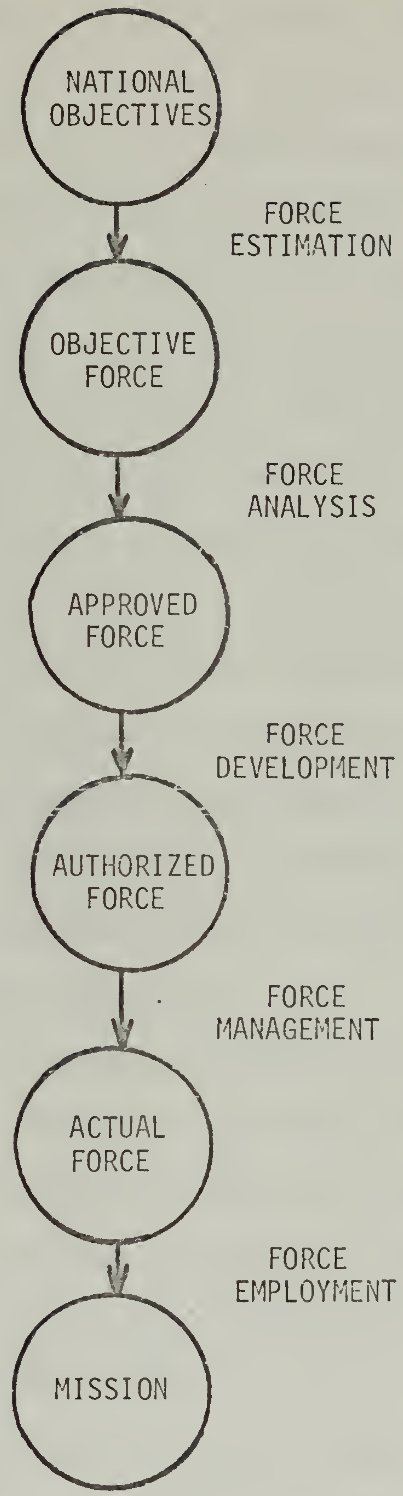

Figure 1. Force Relationships

support of this position, each Service prepares their own estimates of the force levels necessary to accomplish their missions. Necessary, as used above, implies a justified need, which may or may not exist, depending on the viewpoint of the planner analyzing the mission.

The Army's mid-range estimate in the JSOP is the Army Strategic Objective Plan (ASOP). This plan reflects the Army's view on strategy and force levels of their own and the other Services in the accomplishment of the stated national objectives. The ASOP describes more than an aggregated force level for a particular strategy. It is published in two volumes, the first volume translating national and joint military policy, objectives, and strategy into specific Army strategy for guidance in the preparation of alternative Army objective forces and resource requirements that are presented in the second volume. These alternatives depict the areas of deployment, the composition of the forces involved, and other descriptive factors such as assumptions used and cost data. The specific item of the objective force which will be examined is the total force required measured in divisions.

To better understand how the ASOP fits into the overall defense planning effort, it is helpful to review the PPBS which former Secretary of Defense, Robert S. McNamara initiated in 1961.[2] When Mr. McNamara assumed the duties of Secretary of Defense in 1961, he soon found a separation of military planning and budgeting that resulted in lack of coordination and cooperation.[3]

Planning, the responsibility of the Joint Chiefs of Staff and the military departments, was accomplished in terms of military forces and weapons systems. This planning horizon extended over periods of from five to ten years. Budgeting, however, was done for only one year and in terms of functional categories such as military personnel, operations

and maintenance, procurement, research, development, test and evaluation, and military construction. The budgeting operation was done by the civilian secretary and the comptroller organization. Although there was ample planning efforts in both the military and short range fiscal areas, a separation existed which cost the taxpayers millions of dollars each year due to the inefficient management techniques employed in the Department of Defense (DoD).[3]

Secretary McNamara turned to Charles J. Hitch, the DoD's Comptroller at the time and now recognized as a leading authority on program budgeting and the application of economic analysis to defense problems.[2] Dr. Hitch introduced two techniques, programming and systems analysis, to improve high-level planning in DoD. As Dr. Hitch stated after leaving DoD:

> "We introduced programming to make the military planning of the Department realistic, to make it face up to the hard choices by linking it to fiscal planning from which it had been entirely divorced, and we introduced systems analysis to provide a criterion or standard for making those hard choices, to achieve some rationality and optionality in the planning."[4]

The program which Mr. McNamara initiated was a combination of management techniques and was referred to as PPBS. PPBS was founded on six basic ideas:

1. Develop explicit criterion as measures of the need for and adequacy of defense programs
2. Associated fiscal estimates with the respective military requests
3. Provide feasible alternatives to decisions at the highest level in the decision process.
4. Active use of an analytical staff to provide input into the decision-making process.
5. Projection of current decisions into the future to foresee possible implications.

6. Explicit and open analysis to provide credibility and awareness of the basis for military decisions.

The PPBS, established in 1961, is still in being. It is developed on the concept of centralized planning where national security objectives are related to strategy, strategy then matched with forces, forces then linked with resources, and resources with costs.[5] The planning horizons have been defined to be either short-range, mid-range, or long-range. In this context, the ASOP represents the Army's estimate of necessary forces to accomplish their missions in the mid-range period, from five to ten years in the future.

The current Secretary of Defense, Mr. Melvin Laird, has decentralized the planning effort, shifting the burden from OSD to the Services. The ASOP has taken on greater importance by this shift. Mr. Laird has given the Services more authority in the PPBS cycle by making them conduct their own analysis on plans and programs while utilizing the management techniques introduced by Mr. McNamara. The Services have not reverted back to the old procedure of separating fiscal planning from the military planning of weapons sytems and force levels. They are now required to make the "hard choice" as Dr. Hitch said, in reference to the selection and development of programs. The ASOP must consequently translate the national objectives and policies from the President into feasible military objectives which the Army can accomplish within the confined environment of fiscal and military constraints.

The ASOP is a document that has far reaching implications both at home and abroad. It provides a basis for planning military assistance to the Free World countries and for the development and review of

interallied plans.[6] If the perceived threat in one theater exceeds the ability of the Army to counter such a threat, the allies must be encouraged to provide greater support for the accomplishment of the strategic goal.

Now that the background of the Army's ASOP estimate has been examined, the environment in which the estimate is prepared will be discussed. This environment includes those factors which can be identified as having an effect on the preparation of the ASOP estimate. Sources of information, management techniques, time and money constraints, and use of computers are a few of the factors which influence the estimate and which will be discussed in the next section.

III. ENVIRONMENT OF THE ASOP ESTIMATE

The objective of this section is to present the method which the Army currently employs in the estimation process. Appropriate data and analyses must be selected from a number of information sources to construct a credible and workable estimate of the Army's force requirements. This section traces that selection process which yields the estimate by examining the environment which prevails at DCSOPS. The Army's approach to the problem incorporates the extensive use of automated planning systems. One particular planning system, FOREWON, is described and its utility to the planning effort is shown by an example of how it is used in DCSOPS.

A. DATA COLLECTION FOR ASOP

Although other staff agencies provide varying degrees of information for the ASOP, DCSOPS processes, evaluates, and selects the appropriate information for the preparation of the estimate. Other agencies are not required to provide complete ASOP estimates but rather produce estimates of particular problem areas with their associated analysis. Each of these agencies supplies information to substantiate the Army's view on the appropriate level of ground combat forces required to meet perceived contingencies.

It should be noted that in the present sequence of events, the preparation of the ASOP from the numerous inputs precedes the issuance of fiscal and logistical guidance from the Office of the Secretary of Defense. The estimate being prepared by DCSOPS is thus unconstrained by fiscal limitations, although anticipation of the forthcoming budget constraints tempers the estimate.

The initial estimating effort proceeds with a theater by theater determination of the threat. The sources of the threat analysis provide both general and specific interpretations of possible contingencies. Many agencies provide threat analysis for the ASOP estimate. The composite analysis is derived in DCSOPS after receiving the threat appraisals from the numerous sources. DoD planning guidance contains a major portion of the threat analysis in the form of the scenarios which the Services are asked to address in their planning. The past ASOP estimate is a good reference since previous threat considerations should be a valid source for the 5-10 year time frame which must be examined. Supporting intelligence studies are used when the threat envisioned in last year's ASOP has appreciably changed and needs updating.

Once the threats are identified to the satisfaction of the force planners in DCSOPS, the forces required to combat the threat must be determined. This step in the planning process entails an interpretation of U.S. military objectives in the respective theater. Knowledge of fiscal constraints is also necessary to determine how much troop and monetary augmentation will be needed from our Allies to support the Army's contingency missions. If the Army feels a certain troop level must be maintained in a given theater, a reduction in U.S. troop strength necessitates an increase in our Allies troop strength to balance U.S. losses.

There are dangers in translating these objectives into the actual force level that should be established. First, the strategic guidance which is received in support of the defense planning effort seldom appears in the form of space, time, and resources to be used. The terms such

as "successfully defend" or "successfully counterattack" require translation into definitive statements which can be used to generate actual requirements. The vague nature of defend or counterattack provides wide ranges of estimates depending on the interpretation which the planner utilizes in his calculations of how many forces are required to accomplish the mission. The number of forces required to successfully defend forward of the Rhine River for 15 days in Germany are much different from the number necessary to defend the same terrain for 45 days under the same conditions. The interpretation of strategic guidance therefore presents a significant problem for force planners. It should be noted however that recent trends have shown that DoD scenarios are becoming more precise with regard to time and location.

A second danger in translating guidance into concrete factors for planning is the danger of creating a limited number of scenarios with which to analyze the requirements. Force planning agencies outside the Army, such as OASD(SA), question the credibility of strongly scenario-dependent ASOP estimates. Without explicit time and space definitions of strategic missions, the Army converts national military objectives into scenarios which attempt to fit the general guidance to specific situations. This attempt reflects the Army's view of threat and strategy. Planners in OSD view the same situation differently because they must consider the entire military situation not just the Army's part in the strategy. Recently the Army's view on necessary force levels have exceeded OSD's and Congress's willingness to support them since the Army has not treated their strategic position as part of the overall armed forces structure. Each service sees its role in national defense differently than the other services see the respective roles. The Army has never recommended a

Navy force to do the tasks it believes are inherently Army-oriented such as provide helicopter mobile security forces for the LOC traffic which utilizes inland waterways in Vietnam. The Navy, on the other hand, might view the security of ships using inland waterways as a natural extension of their role to protect shipping in the combat zone. The Navy might assign these missions to the Marines while the Army considers the mission theirs and thus two (even three) Services plan for one mission. The same analogy might be extended to larger missions and into the strategic tasks for specific theaters. The planning conflicts of multiple service interpretation of strategic guidance adds another dimension to the problem of force planning.

B. THE ARMY'S APPROACH TO PLANNING

The environment of the ASOP estimate in DCSOPS is characterized by short deadlines. Whether internally or externally generated, the demands for available time hinder a comprehensive and exhaustive ASOP preparation. Past studies, requests from theater CinC's, war game analysis, and "military judgment" provide the bulk of references for the ASOP estimate. Time and money constraints have made it difficult to direct numerous studies to investigate the implications of various force planning policies on ASOP estimates. Contract agencies support the DCSOPS effort in looking at the required force levels in various situations; however, their results generally lack the impact of independent analysis, since they usually are specifically tasked to support the Army's view.

In an effort to shorten the preparation time associated with the ASOP estimate, the Army is relying on the extensive use of combat simulations to substantiate their estimates. Due to this reliance on simulations and war games, the Army's approach to force planning is characterized

as the dynamic approach. In this context, the dynamic approach relates to the interactions of combat elements as they simulate a combat operation. The dynamic approach is favored by the Army because it yields planning benefits which they believe cannot be gained by a static tabulation or inventory-type approach. The static tabulation approach, commonly referred to as the static approach, is characterized by a listing of quantities of forces and weapons sytems and the resultant ratios which are formed using these quantitative lists. The ratios appear in various forms depending upon the questions to which the analysis is directed. Such ratios as friendly tanks to enemy tanks, friendly anti-tank weapons to friendly infantry troops, and enemy aircraft to friendly anti-aircraft missiles are a few of the ratios that might be used in the static approach.

One advantage of the dynamic approach relative to the static approach is gained in the process of programming a dynamic simulation. Many unquantifiable planning factors which are important are considered that the counting approach neglects. For example, many of the parameters and variables of combat can be analyzed in a realistic space and time setting. Parameters are defined here to be a rate or ratio whose value may vary with the circumstances of its application, such as advance rates, casualty rates, and resupply rates. Variables, on the other hand, are referred to in this discussion as inputs which appear as numerical quantities of troops, weapons, and equipment and depends only on forces available, strategy, tactics, and political situations.

C. ATLAS WAR GAME

An example of parameters and inputs in a realistic space and time setting is found in theater level combat simulation, ATLAS. ATLAS can

be programmed to represent land combat on the European Continent in the time frame of 1973. Parameters such as advance rates and replacement rates can be established in order to analyze the results of, for example, increasing the inputs, initial friendly troop strengths, by 10%.

The documentation and user's guide to ATLAS by RAC[7] contains a complete description of the theater model. To summarize that description, ATLAS is comprised of four separate assessment models:

(1) The Ground Combat Model

(2) The Logistics Model

(3) The Tactical Air Model

(4) The Tactical Decision Model

The ground combat model's primary function is to make a daily determination of change of the FEBA in each combat sector. It accomplishes this be determining the force ratios, the comparative ratios of combat effectiveness, and the postures of the engaged troops and consequently establishing the rate of advance of the attacker. The force ratio depends upon artillery, tactical air support, casualties sustained, and the status of supply. Reserves are accepted and entered into combat after they are moved forward by the logistics model. Ineffective divisions due to casualties are removed from combat and withheld long enough to be restored to combat effectiveness before they are returned to combat. These actions are performed in accordance with the values assigned for the parameters, such as supply rates, performance-posture levels, and casualty rates.

The logistics model simulates in a highly aggregated manner the flow of units and supplies in each combat sector from the port of debarkation, through the intermediate points, finally to the forward

supply point. Enemy interdiction of the LOC causes loss of supplies and/or the capacity to continue supply operations. Shortage of supplies results in degradation of combat effectiveness. Although the logistic model ignores many of the complexities of supply, it does measure the capability of LOC to move essential tonnages from the port of entry to the combat divisions.

The air model simulates the use of tactical aircraft and enemy air defenses in the combat theater. Five types of missions are considered: (1) surface-to-air missile suppression, (2) supply interdiction, (3) air base interdiction, (4) close-air support, and (5) air defense. Transport aircraft are simulated by allowing the movement of supplies by air in terms of total tons of supplies between locations within each sector.

Finally, the tactical decision model allocates resources of men and material within the theater according to sector needs and capability to support additional units. Daily allocation of tactical aircraft depends on the type of ground action, opposing air force ratios, aircraft availability, and the status of the air battle. The aggressor's rate of advance or cumulative advance toward some strategic objective determines the assignment of new arrived combat units. Most other units are placed in sectors according to their prescribed tactical doctrine, for example, SAM units. A general summary is shown in Figure 2.

There can be many distinct data values employed in ATLAS. A recent application in a Southeast Asian theater required almost 1000 data values to describe the situation of the two forces.[7] There are over 100 parametric inputs that can be used singularly or in combinations to describe the combat situation. Examples of some of these parameters, as

PREGAME PREPARATION

analysis of situation
inputs aggregated

DATA REQUIRED

geographic limits
opposing strategies
orders of battle
operational data from scenario
tactical air and logistical resources

STRUCTURING THE THEATER OF OPERATIONS

air control authority
layout of sectors
ports of entry

ORGANIZATION FOR COMBAT

maneuver units
artillery support
close air support
inactive and reserve units
scenario phases
logistical considerations

SYSTEM RUN

immediate interpretations of situation
(perhaps return to PREGAME PREPARATION)

RESULTS

complete analysis*

* This analysis includes a comprehensive review of all inputs, parameters, and objectives. The run might be repeated several times in order to achieve satisfactory results. Throughout the above steps there is an implied recycle capability to ensure credible outputs from each previous step.

Figure 2. Summary of Atlas Run

shown in [7], which can be manipulated are given in Table 1. These parameters can be manipulated by system operators in order to produce desired military and strategic objectives. Often the alteration of but a few parameters, such as mobilization and resupply rates, could change the movement of the FEBA and hence change the combat situation.

D. THE FOREWON SYSTEM

There are other questions which can be answered by the dynamic approach that cannot be derived from an analysis of quantitative listings:

1. The effect of alternative assumptions about the timing of mobilization and deployment in relation to the actual outbreak of hostilities,although timed static comparisons can be made.
2. The effects on the progress of battle of possible alternative deployments of available troops.
3. The relationship of troop units to operating space along the battlefront and in depth throughout the area of operations. The number of troops might not be as critical as their displacement within the combat area.
4. The effects of friendly ground lost or gained as it may affect the capabilities of friendly supply and communications lines (LOC).
5. The effects of interdiction campaigns on friendly forces and LOCs.
6. The assessment of assumptions of reasonable variability in the estimated quality and endurance of opposed combat forces.[8]

Although the dynamic approach is viewed by some planning agencies as a "black box" approach, it tends to uncover missed details in new concepts or tactical missions that have never previously been analyzed. In its effort to benefit from the dynamic approach, the Army is utilizing an

COMPUTER NAME	DEFINITION
MXDAY	number of days ATLAS is to be played
NAUM	number of combat units committed to battle on the 1st day
GICE	gross ICE value for committed unit (Index of Combat Effectiveness)
RCVPSA	percentage of an active unit's TOE strength that is replaced each day
RSVMN	minimum percentage of effective combat unit ICE by sector that should be held in reserve
RCVPSV	replacement rate for uncommitted units
WAAL	attrition to attack aircraft from ADA weapons assumed to be available to supply convoys
DYRPLL	day on which replacements begin entering the combat units under non-linear replacement policy
PLMXA	number of days of a "planned day of supply" that each unit tries to keep on hand
FCTC	attrition constant to the fixed-wing transport capability cost because of tactical air interdiction

Table 1. Sample of ATLAS Parameters

automated force planning system, FOREWON. FOREWON consists of five computerized models which allow planners the capability to evaluate force/cost packages so that alternative objective forces are related to their associated costs. FOREWON can accept a wide range of scenarios which reflect the threat analyses and, based on parametric values and given inputs, produces a single objective force. The four major models are:

1. Preliminary Force Designer
2. Objective Force Designer
3. Theater Force Designer
4. Force Cost Accessor

In a typical FOREWON run by DCSOPS, the Preliminary Force Designer operates first. It accomplishes what its name implies; it designs, in a very aggregated fashion, the entire objective force. It utilizes the given values of major variables, such as reserve composition, readiness conditions of units and deployment schedules to deliver divisions which meet the objectives stated for each theater of operation. It utilizes linear programming technique to accomplish its purpose at the least cost and with the most efficient use of inter-theater lift.

While the Preliminary Force Designer addresses all of the theaters simultaneously, the Theater Force Designer structures each of the theater forces one at a time on a much more detailed basis. It consists of the war gaming model, ATLAS, which displays the movement of the FEBA on a daily basis and a force structuring model, FASTALS, which develops a theater troop list.

Upon completion of all the FASTALS runs, the troop lists are collected by the Objective Force Designer. This model combines them

to develop an overall force which is capable, according to Army interpretation, of handling the situation which it has considered. After the Objective Force is determined, the Force Cost Assessor then costs the force. It computes the operating costs of the forces at the beginning of the planning period, the operating costs of the objective force, and the cost of changing from the present force to the objective force.

All of the computer models are being operated under the control of the Army Staff. DCSOPS is charged with responsibility for the overall system operation; ACSFOR is responsible for FASTALS, and the Comptroller is responsible for the Force Cost Assessor. The remaining models are run for DCSOPS by STAG. The first complete exercise in 1970 utilizing FOREWON took about three months, however subsequent runs have reduced the time considerably. Sensitivity analysis is performed quickly on FOREWON. For example, NSSM-84 expanded the scenarios that had to be examined.[9] As a result, JCS requested the Army to develop force requirements for 21 different scenarios which it was able to do in one week.[9] The big advantage of FOREWON is its capability to quickly offer insights into decision makers' "what if" questions.

E. SAMPLE FOREWON EXERCISE

In order to highlight how FOREWON is used in DCSOPS, a sample run of the entire system gives an example of the utility of the automated force planning system to the force planner. The example describes a typical FOREWON exercise and the resulting analysis that must be performed to derive meaningful results from the computer outputs. These outputs are the alternate objective forces which are described

by the necessary forces, peacetime stations, lift systems, costs, mission performance, and the key assumptions with the planning parameters. As was mentioned earlier, only the force level expressed in division size units are examined in the proposed decision model, however, these are not the only results provided by FOREWON.

The Preliminary Force Designer generates a closure schedule of divisions, ISIs and SSIs for each of the theaters of operations. A normal delay in closure of 60 days is applied to the SSIs in order to reduce the work loads for inter-theater lift and force readiness factors of reserves. Given the schedule, ATLAS determines the FEBA position throughout the war on a daily basis. Normally, several runs must be made to assure the ATLAS results are consistent with "sound military results." This aspect of the FOREWON is examined in the concluding sections of this thesis.

At this point, if the military objectives are not achieved, the planners must go back to the Preliminary Force Designer and either change the closure times in the model or request additional lift in order to get more divisions to the theater faster. Assuming the FEBA is satisfactory, FASTALS is then operated to develop a set of time-phased troop lists. A separate troop list for each of ten time periods which have previously been defined is generated.

At this point, the planners check to see if the tonnages and troop strength of FASTALS are compatible with the tonnages and strengths in the Preliminary Force Designer output. A frequently encountered problem is that the FASTALS output is greater than that of the Preliminary Force Designer in the early time periods. If this happens, the planners must increase lag times in FASTALS for various administrative nd support

type elements in order to decrease the deployment time of combat units or specify more lift.

When the support units have been delayed as long as practical, the problem of reducing the movement tonnages by changing the combat force must be answered. If units such as artillery are delayed, the simulated war might be adversely affected and result in starting the FOREWON run again from the beginning. It may, however, be possible to reduce the intensity of the war and still achieve the military objective. In some cases, the objective itself might be altered to achieve meaningful results. This alteration not only includes planning manipulation but also tactical considerations as how to best accomplish the objective.

When FOREWON results have satisfied the planners at this stage of the run, the objective force is then computed on the basis of providing the required forces for each theater troop list, being certain to check to see if the combined force exceeds "reasonable" limits. Allocation rules in FASTALS must be changed if the forces designated for each theater troop list total a combined force that is excessive in terms of actual and projected resources. If the FASTALS allocation rules are changed, the entire system must again be analyzed to determine the effect of a new allocation schedule. If the combined force is acceptable to the planners, the Force Cost Assessor costs the objective force.

In the next section an alternative approach toward force planning is examined. This asset counting approach is used in OSD and was referred to as the "static approach" due to its reliance on the listing of combat elements. This alternate approach is discussed in comparison to the Army's approach. The advantages and disadvantages of the static approach are also examined.

IV. AN ALTERNATE APPROACH TO PLANNING

While the Army force planners rely on their "dynamic approach" to force planning, there is another approach which is practiced in DoD. This section discusses the approach which force planners in OSD utilize to answer the same planning questions which face the Army although OSD must address the entire military effort while the Army looks at their role in the "big picture." OSD's approach is referred to as a "static approach." OSD has recently shown more interest in the future of the dynamic approach while still favoring the static approach at the present time. The approach is static because it is based on a system which counts assets as the basis for force estimation analysis. The discussion includes the advantages and disadvantages of the static approach, a comparison with the "dynamic approach," and a theoretical example of how potential for success or failure of a military campaign based on the numbers of troops or weapons sytem and the subsequent comparisons against evemy troops and weapons are difficult to solve. Certainly the comparisons of two force strengths gives an indication as to how the battle <u>should</u> go, however, the complexities of war negate such an uncomplicated solution to the planning problem.

The purpose of static indicators is to provide insights into the required force levels needed to achieve national objectives. They offer some useful management information which OSD analysts use to derive force potential. They can be used in a comparative analysis to determine how they correspond to similar indicators of potential enemy forces. They also provide a basis for year to year comparison of static indicators of forces and weapon systems.

The force planning effort in OSD is centered in OASD(SA). Although there appears to be future changes in OASD(SA)'s force planning endeavors, the static approach is currently utilized to determine required force level for all services, not just the Army. This static method incorporates an analysis of so-called static measures of force capability. The four general types are:

1. Inventories of manpower and major equipment items
2. Abstract measures of armament items (such as casualty potential, firepower, effectiveness, etc.)
3. Operational characteristics of major weapons systems
4. Physical characteristics of major weapon systems

The problems encountered by appraising the force potential of units by using static indicators are shown by force comparisons improving or deteriorating over time. For example, this year's increase in the number of anti-tank (AT) weapons systems in the airborne division compared to the number of AT weapon systems of previous years gives an indication of relative AT potential of the current division versus the past division's potential. These comparisons or ratios are only significant as they relate to themselves or other similar listings.

A shortcoming of this comparison of aggregated weapons is that it assumes the same capabilities for all weapons in the aggregated total. This could only be true if all weapons were the exact model with no modifications. For example, it would be acceptable to total the firepower potential of the infantry's rifle if they all were M-16s. However, it is inappropriate to state that each anti-tank weapon in the infantry contributes the same capabilities. The infantry's light anti-tank weapon (LAW) has much different characteristics and capabiliti than the helicopter-borne anti-tank systems.

A determination of effectiveness of troop level or weapon systems, such as AT weapons, is more elusive to define since the interactions of the systems must be considered. If war was fought on the basis of tabulating troops and weapons and determining the winner based on the highest number of assets, the static indicators would provide a fool-proof answer to the question of "how much is enough?" Unfortunately, wars are not waged in this manner.

To some analysts, the static approach has definite appeal. It allows the analysts to present the decision makers with alternatives which are based on quantifiable judgments. The Army's "black box" approach seems to imply a mysterious treatment of combat variables which often in the past has been manipulated to produce the desired result. The static approach eliminates these variables such as weapon systems interactions and interdiction, in its determination of required force levels. The merit of the OSD's approach is that it allows open presentation of force level analysis, that is, it justifies the results with actual numbers without relying on manipulated assumptions to model the combat situation.

OSD planners defend their static indicators approach on the basis that the Army's system does not produce a valid enough estimate. This problem of validity will be discussed in a later section. OSD planners maintain that the computer simulations of combat have not reached the level of sophistication that is necessary to produce worthwhile analytical results. Since they do not believe that the FOREWON system and other automated simulations presently have utility in force planning, they use static indicators to gain insight in planning.

There are many valid reasons to dispute the results of FOREWON solely on the operation and interpretation of ATLAS. First, simulating the conduct of battle is a highly complicated task since it entails consideration of many factors that are not easily quantitatively defined. Effectiveness in combat is an example of an abstract concept that must be measured if conclusions are going to be made concerning comparative relationships between friendly and enemy forces. Although much recent study has been conducted by research groups, such as RAC, in modeling land combat, past experience with these models has not led to complete acceptance by the services and OSD. Some of the unacceptable aspects of combat modeling are discussed in a subsequent section.

In addition to the treatment of war gaming in each of OSD's and the Army approaches to force planning, a more basic difference exists in their force planning methodology - the planning objective. While the Army attempts to justify their needs based on their own plans and programs, OSD must manage the entire military program and mesh the biased services' estimates with their own estimates in order to establish a force which is acceptable to the President and Congress. OSD's planning is accomplished in light of strict budgetary and strategic guidance while the Army is not bound by the same rigidity of constraints. The defense budget may be divided many ways among the services and the Army attempts to secure as large of portion of that budget as possible. DoD is going to get a fixed percentage of the total budget and no more.

Analysts in OSD use the static indicators they believe give the best insight into relating military needs to national objectives. The force level

estimates however require a subjective opinion on what indicators are important and necessary to achieve the desired military result. The decision makers are thus required to choose between alternatives in force levels without an analysis of certain important aspects of land combat. For example:

1. The kinematics of battle
2. The relative effects of interdiction on logistics capabilities
3. The effects of maneuver and redeployment alternatives
4. The effects of assumptions on mobilization
5. Parametric treatment of uncertain parameters such as movement rates, terrain and weather, and firepower.[10]

Although the FOREWON system, specifically ATLAS, does not provide exact answers to the above problems, it provides approximations of each aspect to allow their respective analysis in viewing land combat.

Since the Army considers the analysis of force interactions important in force planning, ODCSOPS initiated an informal study of the recent Arab - Israeli War using OSD's static indicators to predict a winner in the conflict. Using the static indicators, the result was an Arab victory - an incorrect answer. To correct the obvious deficiencies pointed out by the ODCSOPS study, OSD modified their indicators.[11]

The resultant indicators, called qualitative force indicators, attempt to determine the military potential of a country by scoring a certain number of points (0 to 100) for one or more qualitative measures of combat capabilities. A list of qualitative force indicators is given in Table 2. Using the new indicators the Arab-Israeli War was analyzed again and this time an Israeli victory was predicted. The new, and

seemingly correct answer, did not satisfy some critics of the static approach.

RAC formulated a hypothetical conflict between two fictitious countries in order to demonstrate the deficiencies in the new qualitative force indicators. The investigation showed that five of the indicators listed in Table 2 (B,E,G,L,M) will give high scores to a side based solely on the quality of the force, independent of the absolute quantity of the force.

Although the reinforcement capability is discussed in this review of RAC's example, the main point is that the emphasis placed on quality over quantity is overbalanced in using the qualitative force indicators. The proposed system of static indicators needs revision as the example will show.

The score for any measure is computed by: (1) scoring 100 points for the side superior in that measure; and (2) scoring the inferior side a number of points in proportion to the ratio of the value of its measure to the superior side. Thus if the 60-day mobilization increment of one side is 100,000 men and that of the other of two equal sides is 50,000 men, the superior side gets 100 points while the inferior side gets 50 points. The important point is the fact that it is based on a percentage of the initial forces.

RAC showed that an extremely small, rich country which had a small, but well equipped, active Army and a capability of rapidly mobilizing a reserve force of equal strength could usually demonstrate a high potential for combat according to OSD's revised indicators. In their example, Ministat, a country with a total population of 100 and a well equipped Army of 15, demonstrated a greater combat potential than the combined Arab strength as assigned to the other fictitious country.

A. 60-day mobilization increment

B. 15-day mobilization increment

C. Active strength

D. Firepower score

E. Operational Equipment/Total Equipment

F. GNP

G. GNP/Population

H. Active Divisions

I. Population

J. 30-day land force reinforcement increment

K. Tanks + Arty + APC

L. Other Support Personnel/Cbt Support Personnel

M. (Tanks and APC)/Active Strength

N. Tactical Aircraft

Table 2. Representative Static Indicators

Since both the Army's and OSD's methodologies have been discussed, it is appropriate to observe how DCSOPS develops its ASOP estimate in the light of the two conflicting approaches to force planning. The proposed decision model for the ASOP estimate attempts to portray a deliveratelу simplified picture of a complicated process in order to gain insight into the ASOP preparation problem.

V. PROPOSED DECISION MODEL

In modeling the decision process within ODCSOPS for the ASOP estimate, four questions must be asked:

1. What factors are relevant to the ASOP decision?
2. Which of the above factors can be described numerically or quantified?
3. How can the list of quantifiable factors be reduced by aggregation and still contribute toward developing a better model.
4. What is the relationship between the elements and how can this relationship be described analytically?[10]

The equations of the decision model represent the answers to these questions. The factors which could be identified and subsequently defined in a functional relationship appear in the formula. This section describes how the decision formula relates to the actual process by detailing the inputs used in its foundation. This decision model is based on the author's evaluation of ASOP planning procedures, intuition on how various planning factors interact, and approximations of numerous detailed processes that make up the decision process.

Within ODCSOPS, the development of the force level estimates can be traced from the multiple informational inputs, through the estimation process, and finally to the ASOP decision which is submitted to the Army's chain of command for integration into the JSOP. The entire process resembles that much referenced "black box" into which information is fed and out of which comes the force level estimate for the ASOP. It is this "black box" process that the decision model attempts to describe. The intangible factors such

as command influences, work-load factors in DCSOPS, and the technical competency of the staff providing support to DCSOPS are not addressed.

Command influences included the tendencies of personnel in higher staff positions outside the ODCSOPS to change or otherwise affect the ASOP estimate. Technical competency of supporting personnel is considered to be constant for all ASOP estimates, that is, no estimating process is adversely affected by the abilities of supporting sections. Although the work loads within ODCSOPS vary from year to year, no predictive scheme has been developed to anticipate how these factors affect the ASOP estimate. The reason that these factors are not built into the model is that they cannot be quantified from one ASOP to another. That is, although some ASOP estimates might be influenced to a great degree by the computer support available, an increase or decrease in the quality and quantity of support does not significantly affect the process itself and hence the decision model.

The model consists of two basic mathematical functions which combine to yield the actual ASOP estimate which ODCSOPS submits to the Army chain of command for approval and/or revision. In analytical form it states:

(1) $D(T) = \alpha \cdot F + \beta \cdot d[PS, CR, MJ, JP]$

(2) $\alpha + \beta = 1.0$

where:

D(T): a scalar which represents the T^{th} year ASOP estimate expressed in units of DFE

α : weighting factor attached to FOREWON results

F : FOREWON estimate of troop levels

β : weighting factor attached to non-FOREWON estimate sources

d[PS,CR,MJ,JP]: function of non-FOREWON estimates for the ASOP estimate expressed in DFEs where:

PS: Past studies and previous ASOP estimates

CR: Command requirements as seen by theater CinCs

MJ: "Military Judgment" in the form of staff interpretation of force requirements

JP: Combined planning estimates from joint OSD?Army effort

d[PS,CR,MJ,JP] might appear in various functional forms. For example:

$$d[PS,CR,MJ,JP] = [.8PS + .15CR + .9MJ + .2JP].25$$

or

$$d[PS,CR,MJ,JP] = [.5PS + .3JP] + JP \cdot MJ$$

In each of the above hypothetical forms, the value of d[PS,CR,MJ,JP] is the total DFEs needed for the ASOP estimate. The justification of the impact of each of the function's variables is discussed later.

In order to understand how the model relates to the real world of force planning, each element is discussed to show its relationship to the model's final result - the DCSOPS's estimate.

The decision which leaves DCSOPS has been restricted in this discussion to be the force level estimates expressed in units of U.S. division size elements. Although the structure of the U.S. Army division can vary, the division unit here is comprised of nine maneuver battalions. For example, D(72) is the ASOP estimate for the 1972 PPBS cycle. It is the number of DFEs estimated to be required for the specified mid-range planning horizons of the 1972 PPBS cycle. The actual ASOP presents alternative

objective forces allocated for specific areas. The model is interested solely in the determination of aggregated force levels displayed in DFEs.

The weighting factors, α and β, sum to 1.0 and thus represent the proportion of emphasis (or reliability) placed on FOREWON results and the non-FOREWON function, d[PS,CR,MJ,JP]. At present, the weighting factors each appear at a positive level. Even if the FOREWON results could be relied on to give accurate estimates of required force levels, the composition of the active and inactive Army strengths reflects many units that do not get treated in a FOREWON analysis. The DFEs used in FOREWON comprise only one of three force categories in the Army. The categories are:

1. <u>The Division Force</u> which comprise U.S. Army divisions and command and support units that accompany them into combat (DFEs included)
2. <u>Special Mission Forces</u> which are required for military missions separate from those assigned to divisions (Special Forces is an example)
3. <u>General Support Forces</u> which house, equip, and train the Army (Basic Training Units, CONUS support)

The General Support Forces are not included in FOREWON analysis while Special Mission Forces <u>might</u> be included. It is felt that there exists a definite correlation between the size of the DFE and General Support Forces necessary to support the DFEs. About 85% of the Army Reserves are programmed in FOREWON because their composition is mainly combat or combat support type units and are not basically CONUS support.

A high value of α indicates a heavy weighting to FOREWON generated force estimates. Ideally, the FOREWON system should give exact answers

to the force planning problem but the state of the art in computer simulations of land combat somewhat restricts the use of FOREWON results. The combat assumptions necessary to make the ATLAS war game work in FOREWON often oversimplify the complexities of land combat. The dilemna of overcomplication versus oversimplification in modeling comes to light in the construction of the ATLAS war game, consequently, the results must be analyzed with appreciation of this problem.

The next term in the model to examine is the FOREWON result, F. The basic models of FOREWON have been previously described and their use in DCSOPS planning effort has been shown. FOREWON not only provides a strategy/force/cost proposal based on a specific set of inputs, it offers the decision-makers the option of analyzing a group of alternative structures based on different inputs. The ability to analyze a group of alternative structures is certainly a benefit of the FOREWON. However, this benefit has also been misused. Manipulation of various scenarios offers force planners the capability to develop specific scenarios and situations which support the Army's position. The resulting analysis on a "manipulated" scenario lacks independent and meaningful interpretation. Thus the ability to check a greater number of scenarios can be used to produce an insensitive and invalid view of the interactions of combat forces in the theater simulation, ATLAS. Although a worthwhile objective of the Army's planning effort is to view a greater number of scenarios, this objective should be placed in the proper perspective. The same criticism of the manipulated scenarios can be applied to the selection of values for the parameters within the FOREWON system.

Continuing criticism of combat models, specifically ATLAS, appears to be based on two major areas of war game construction, form and parametric

treatment of combat variables. There is a definite relationship between these two areas since war game form often dictates the parameters, however this discussion will treat both separately for clarity of presentation. First, the form of the war game is usually a balance of events and interactions which is not too complicated nor oversimplified. A form which is too complicated often is cumbersome and not meaningful in its interpretation. On the other hand, a war gaming form that neglects many of the important combat interactions limits the scope of the game and hence the credibility of the results. Somewhere between the too complex and the oversimplified treatment of land combat is a form which is mathematically tractable and representative of the combat which is to be analyzed. Lanchester war games models are examples of the latter.

The parameters which have caused the most criticism are those which appear to have no apparent substantial empirical base. Only recently has a significant effort been made by analysts and historians to document past combat engagements in order to determine the value of such parameters as casualty rates, replacement rates, kill probabilities, and advance rates. Of course, one may question the validity of relying on past data to model further conflicts. However, the objective of the entire war gaming effort is to gain insights into the complexities of war and make better estimates of future requirements. Combat modeling provides a mechanism for systematic and comprehensive conjecture about future contingencies. As the FOREWON system is refined and updated with the improvement of gaming techniques, its output, expressed in the model as F, becomes more meaningful in force planning. This would affect the decision model by increasing the value of α, the FOREWON weighting coefficient.

In this effort to improve FOREWON, the war gaming aspect of the system has been the center of the research effort. The research task of developing a combat simulator that would incorporate certain features which have caused the criticism of ATLAS concentrates on two areas. First, the elimination of the dependence of battle outcomes on force ratios derived from comparisons of friendly and opposed firepower scores is considered important. Second, the evaluations of theater battle at several echelons from corps down through brigades is another feature sought. RAC's Theater Combat Model (TCM) attempts to resolve some of the deficiencies of ATLAS and may be the next generation war game for FOREWON.

The other term in the decision model is d[PS,CR,MJ,JP], expressed in units of DFEs. Its associated weighting coefficient, β , relates the proportionally of the ASOP estimate that can be attributed to non-FOREWON factors. This function is comprised of four major, indentifiable variables: past studies (PS); theater CinC's requests (CR); military judgment as seen in staff analysis (MJ); and joint OSD/Army planning estimates. Although each variable in itself produces some level of force estimate which can be expressed in DFE units, the scope and parameters of the estimates are not identical.

For example, a past Army study, PS, might be referenced in order to determine a troop estimate for a specific country given a certain set of political conditions, while the CinC, United States Forces in Europe might estimate his requirements for the European theater under a different set of conditions. It is the responsibility of DCSOPS force planners to combine the various inputs and references to subjectively determine the value of d[PS,CR,MJ,JP]. It might be as easy as referring to D[T-1] to arrive at D(T) however the political and military situations seldom remain

stable or predictable enough to allow such an uncomplicated solution to the planning problem.

Another component of d[PS,CR,MJ,JP] is military judgment. Although it can be said that military judgment appears in all of the planning sources, in the model it appears exclusively in the form of command guidance, staff actions, and individual assessment of the varied inputs to the estimation process. The planning staff in ODCSOPS continually adjusts their estimates in response to new guidance from higher authorities. This might appear in the form of budgetary constraints or a new technical development which would affect the estimate for the ASOP's planning horizon. Often, staff sections produce studies and reports based solely on the military interpretation of certain actions which also could affect the ASOP estimate. It is this set of informational inputs that are characterized as "military judgment" in the model's function, d[PS,CR,MJ,JP].

The remaining two terms in d[PS,CR,MJ,JP] that need explanation are CR and JP. CR stands for the theater CinC's request for specific troop levels based on their own threat analysis and knowledge of their theater's operations. These estimates from the respective CinCs constitute a somewhat biased view of the needs of each theater however the estimates contain many valid planning considerations. The CinCs are obviously closer to the problem than the planners located in the Pentagon. The CinCs can offer first hand judgments on the preparedness of Allied units and their potential to accomplish assigned combat tasks.

Another easily referenced input in the model is JP, or joint planning estimates by OSD/Army planning efforts. Not all the force planning in the Pentagon is conducted in the isolation of the separate departments or

services. Joint OSD/Army studies are prepared in the force planning field. The scope of these studies is not as extensive as the ASOP estimate however. Recently, many of these efforts have concentrated on the force level problems in Southeast Asia. Regardless of the scope of the joint effort, it takes an important role in the ASOP estimation effort because it represents a convergence of ARMY and OSD approaches to the force planning problem.

The function, d[PS,CR,MJ,JP], may take on various forms in the yearly ASOP estimates. It might be that the term CR assumes greater importance for a particular yearly estimate. Whatever the functional form that the term takes on, it merely reflects the emphasis placed on the non-FOREWON planning estimates. Rarely can the exact form be determined because of the flexible nature of the planning process and the variability of non-FOREWON inputs.

In the economic-political atmosphere that prevails in the determination of military strategy and posture, several alternative lower levels of forces below the "worst case" must be analyzed.[2] The ASOP planners must choose a level below the "worst case" requirements which satisfy fiscal and military constraints and also demonstrate acceptability by the Army, JCS, and OSD planners. A tradeoff of acceptance of the ASOP estimate for the increased probability of failure to accomplish the Army's objectives is attempted in the consideration of lower, less conservative force levels. The impact of the resultant "tradeoff" force must be closely analyzed by ASOP planners who must evaluate the strategic "adequacy" of projected forces.

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[2]"Worst case" refers to the most pessimistic view of friendly capabilities and optimistic view of enemy capabilities.

Now that the decision model has been discussed, there are two important factors of force planning that the model must handle and hence need to be examined. These factors are:

1. Scenario risk
2. Risk in the effectiveness model

Scenario risk is defined here to be the chance of failing to accurately describe the set of conditions which most likely would occur in a conflict situation. That is, the scenario should clearly depict a combat situation that might conceivably take place. Here, risk in the effectiveness model is defined to be the probability that the values of the model's parameters represent the most logical description of the activity they model. In this context, the parameters of ATLAS should represent a set of feasible and realistic parameter values. If they do not, there is an associated risk in accepting the results of ATLAS. Firepower scores are an example of parameters which should adequately describe an activity, in this case, the fire potential of a combat unit.

The treatment of scenario development in the ASOP planning environment has caused much debate among other planning agencies, such as OASD(SA). Some of the concern has been centered on the scenarios' apparent inability to describe a foreseeable combat situation. One reason for this concern is the diverse opinions on how to interpret strategic guidance. Army planners attempt to translate strategic guidance into hypothetical combat. The development of scenarios from the guidance entails a process of translating broad concepts, such as attack or defend, into time and space situations. Scenarios depict the combat situation together with its associated rates of advance, casualty rates, deployment schedules, and other combat parameters. The problem which occurs frequently in force planning is that combat requirements to which the fighting capabilities are addressed are usually the "worst case" situation.

The "worst case" situation involves the highest conceivable threat, the shortest preparedness times, and the most pessimistic evaluation of the capabilities of friendly forces, and optimistic evaluation of enemy forces. This does not imply that determining requirements against the "worst case" is improper for force planning. This approach, as should be noted by all personnel reviewing the requirements, produces estimates that are very conservative and generally the upper bound on required force levels.

Scenario risk can be quantified by manipulating the variables in the given scenario. Examples of these variables are mobilization times, warning times, available support from Allied nations, and advance rates of attacking forces. Each of these variables can be expressed in units of time, numbers of troops, or amounts of land seized. When the mobilization times of friendly reserve units are lengthened, there is a degree of scenario risk which is associated with the resultant change. The scenario might now represent an unrealistic situation and produce requirements that greatly exceed even pessimistic combat demands. The Army planners must shomhow present their estimates for requirements with a clear description of their interpretation of scenario risk with each specific estimate.

Risk in the effectiveness model must be considered when considering the utility of the model. There are numerous risk considerations that could effect the model. One of these considerations is the availability of acceptable values for combat activities. Good empirical values are not always available for certain parameters of combat. The dynamic effects of warfare have not been adequately described in the current state of the art to permit anything but a "best guess" approach to assigning certain combat values. These "best guess" values affec the credibility

of the model and hence decrease the probability (increase the risk) that the model realistically represents the situation. For example, force ratios as determined by firepower scores represent a "best guess" toward the problem of assigning a unit some measure of combat potential.

Another risk consideration for the effectiveness model is the divergence of "verified" parameter values. This divergence, or spread, represents a range of values which, depending upon the situation, can be supported by an examination of operational or test data. As was mentioned in the "worst case" discussion, there is a corresponding confidence associated with these values as they vary between their upper and lower bounds. By assigning values in the extremes of the acceptability spread, the planner can provide a hedge against possible shortcomings in analysis. That is, the planner who uses low values for friendly activities and correspondingly high values for enemy activities produces extremely conservative estimates of what interactions occur.

Another consideration inherent in examining the effectiveness model is the opportunity to alter parameter values to produce desired results. Similar to the treatment of scenario risk, the model can be a function of manipulation of parameter values. In large scale simulations of combat, the "black box" approach can hide many of the "massaged" values of the complicated model. This does not imply that force planners purposely alter values in the models to achieve a set of objectives. The confidence expressed in results from the model should reflect the possibility that such a procedure could occur however.

Up to this point, the treatment of risk has dealt primarily with the assignment of parameter values. There is another important consideration of risk that should be noted. Risk in the effectiveness model is a function of the attitude of those examining it. It is a difficult

task to distinguish between a planners desires to conservatively model a situation and a concerted effort to produce a desired results. This problem of distinguishing the intent of planners in their estimation effort is strongly related to their attitude toward risk. Attitude toward risk can be associated with the confidence that is expressed in the model's ability to produce desired results. For example, military planners who view force estimation with the outlook of possibly operating in combat with that force prefer low risk and high confidence in the models utilized. A civilian planner, as a non-combatant, might tradeoff the risk in accomplishing the combat mission for a reduced expenditure of resources. Throughout the force planning process, the risk in accepting model's results is varied accordingly to the viewer's attitude toward risk.

For Army planners, a thorough understanding of the objectives and limitations of dynamic models used to represent the real situation is essential. Strict reliance on ATLAS results without some appreciation of the problems of the war gaming tends to produce estimates that lack credibility. On the other hand, OASD(SA) planners who rely on static indicators in order to estimate requirements for dynamic situations should also understand the limitations and implications of their approach. It should be noted here that planners from OSD have demonstrated more interest in the utility of the dynamic approach. Perhaps the future will bring a merger of the two methodologies and a corresponding understanding of the different levels of force planning problems.

In summary of this section, the decision model can be seen to describe a process within ODCSOPS that annually presents an ASOP estimate for the PPBS cycle. Along with the functional relationships that were examined, a review of two key factors in force planning, scenario risk and risk in

the effectiveness model, were discussed as they apply to the decision model. Next, the validity of the model is presented in the following section.

VI. EXAMINING THE VALIDITY OF THE MODEL

In this section the validity of both the decision model and the model's inputs are discussed. There is a significant difference between evaluating the model's validity and evaluating the information on which the model is based. The model's validity is defined to the the ability of the model's functional relationships to portray the actual decision process. However, the inputs' validity refers to the accuracy and applicability of the information which is used by the decision model. The purpose of this section is to view both aspects of validity and then suggest possible research areas which might answer the questions proposed by the examination.

A. VALIDITY OF THE MODEL'S EQUATIONS

The decision model's equations attempt to show the relationship of FOREWON results to non-FOREWON results in the ASOP estimate planning effort in ODCSOPS. The Army's ultimate decision as to how many Army divisions to ask for in the ASOP might not be a function of DCSOPS ASOP estimate alone. In this discussion however, the unquantifiable influences outside the planning environment of ODCSOPS are not considered, however, they possibly could affect the validity of the estimate. The problem then becomes one of comparing the model's results with past ODCSOPS estimates.

Since the model describes the process which produces the ASOP, one method of testing the validity of the model is to examine past products of DCSOPS's planning efforts and compare the ASOP estimate to the functional form of the model. That is, reconstruct the past decisions in terms of the model's variables and establish the patterns of the decision process. For example, this procedure might indicate an increasing reliance

on FOREWON results which could be observed in increasing values of the FOREWON weighting coefficient.

Unquantifiable planning factors, such as morale, and command influence,have been mentioned earlier in this discussion. It is possible that these factors exert a strong influence on the ASOP estimate. Although it would be easy to describe such influences by the addition of a "catch-all" or miscellaneous function, it would not aid in the analysis of how the decision process works. The purpose of the decision model is not solely to provide logical consistency in the explanation of the process, but rather to allow insights to be drawn from the descriptive portrayal of ODCSOPS's ASOP process.

There should be some method of quantifying each of the variables in the model's equation if they are to be analyzed. The results of FOREWON runs are easily referenced since they provide their own computer printouts. The other variables which were introduced (PS,CR,MJ,JP) are not as easily quantified, although the task is not impossible. Past studies, PS, are usually referenced in the consideration of a particular area or situation and, as such, their contributions in the ASOP estimate could be identified. The CinCs requests also appear in written form and explain in detail the CinCs' estimate of the situation in their theaters and the necessary resources needed to accomplish the mission. Military judgment, MJ, is perhaps the most difficult variable to quantify. A force planner could conceivably assemble the estimates of the other variables on his desk when preparing the ASOP estimate, however, military judgment and interpretation appears in some form in every planning variable. As such, it is difficult to separate and affix a value for its contribution in ASOP. On the other hand, military judgment also appears in the form of staff studies and

command guidance. Quantification of military judgment, although difficult, is considered necessary to demonstrate its impact on the estimation process of ODCSOPS. Joint planning efforts, JP, are another easily referenced and quantified variable since the results of these efforts are usually documented in some form of force units, which again could be converted to DFEs.

The major problem is not quantifying the variables but determining what impact each has on the structure of the model's formula. This difficulty in identifying the formula's structure might be overcome by utilizing a reporting system on each submission of the ASOP. It would list the sources that were used for the estimate and a description of their contribution in the process. Since many personnel prepare the estimate, knowing how the ASOP estimate "fits together" from the numerous sources would assist ODCSOPS in analyzing how and where its planning effort is directed. This "effort-evaluation" procedure was mentioned previously in the introduction.

Once the relationships of the model's variables are known, it is desirable to extend this knowledge of the relationships to gain useful insights. Utilizing statistical methods, such as regression analysis and analysis of variance, the model can be examined with the variables quantified as discussed above. To illustrate how the model might be analyzed, a generalized example is presented which is limited due to the complexity of the process.

This example assumes a linear form of the decision model. It is then possible to examine the values of the DCSOPS estimate when compared to the estimate of the FOREWON system. This procedure is appropriate

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because each of these variables are easily quantified for any given ASOP. The structure of the form would then be:

$$D(T) = \theta_1 F + \theta_2 + E$$

where $D(T)$: DCSOPS estimate for year T

θ_1 : regression coefficient

F : FOREWON estimate

θ_2 : intercept term (non-FOREWON influences)

When viewed as shown above, θ_2 represents the impact of non-FOREWON estimates on the decision. It may be determined by a regression analysis in which each variable in the linear form of the model or the above model is examined to provide an estimate of the impact of non-FOREWON influences. Assuming that the value of θ_2 gives a close approximation to the average impact of non-FOREWON influences, it would be beneficial to look at the variance of the D(T). There is a certain amount of variance normally associated with D(T), expressed $Var(\theta_1 F + \theta_2)$. Any unexplained variance observed in the analysis of D(T) can consequently be attributed to the non-FOREWON influences on D(T) since the FOREWON estimates, F, are known from year to year. By observing these variances over a successive number of ASOP cycles, trends might be recognized for the influence of FOREWON and non-FOREWON estimates on D(T).

However, it should be noted that the above techniques for looking at D(T) also has certain difficulties. Because of the frequent uncertainty about basic variables and mechanisms of the ASOP process, caution should be exercised in analyzing the model's results. Just because a particular functional relationship has been assumed and a specific computational procedure followed, it is dangerous to infer that a change in one variable

causes a change in another variable. [12] The statistical analysis is only a tool to aid in the interpretation of data and not a foolproof indicator of how the model operates in the changing environment of the Army's ASOP decision.

B. VALIDITY OF THE MODEL'S INPUTS

Even if the decision model accurately depicted the actual estimation process, the results of the model could be discredited because of invalid inputs which the model might utilize. The examination of the inputs' validity is centered upon a review of ATLAS. There are a number of reasons for this approach. First, ATLAS is the backbone of the FOREWON structure since it provides the determination of the effectiveness of combat forces in the theater environment. Another reason to review the FOREWON's validity, in particular ATLAS, is that the non-FOREWON inputs are not easily analyzed since they cannot be presented in a standard form from one ASOP to the next. Until the contributions of each variable in the function, d[PS,CR,MJ,JP], can be identified, their validity in the final form of the ASOP estimate is impossible to evaluate. For these reasons, the examination of the inputs validity will be limited to looking at ATLAS.

There are many and varied parameters in ATLAS which could be analyzed to determine if they had an empirical or scientific basis. These parameters are considered here in conventional warfare not in nuclear environment. Of the numerous parameters, those most often criticized are firepower calculations, casualty and replacements rates, advance rates, and measurements of terrain, posture and maneuver. These parameters are discussed in the light of influencing the validity of ATLAS, the FOREWON system, and hence the proposed decision model.

1. Measuring Firepower

The firepower of a land combat force is usually considered to consist of commonly available and employed individual and crew-served weapons such as rifles, machine guns, mortars, howitzers, and recoilless rifles, tank guns, anti-tank guns, and some missiles and rockets. Ideally, a system for measuring firepower would result in each weapon being assigned a number representing that weapon's value in combat relative to all the other weapons used. Unfortunately the value of a weapon depends upon the circumstances of use. Most firepower measurement systems aggregate the "balanced" potential of a battalion or larger unit. The aggregation of firepower potential entails a procedure of totaling the casualty-producing effects of each weapon and determining some measure of that potential. The most commonly used measure is called the "lethal area."

The lethal area of a projectile is derived by an analysis of the number, shape, velocity, and distribution of the fragments from that projectile. Experimentally derived knowledge of the effect such fragments could have on human flesh and bones is readily available. Although the measure includes all of the known characteristics of the projectile, the uncontrollable variables associated with the explosion of a shell tend to detract from the preciseness of the measure.. The inherent differences from shell to shell in such characteristics as metal-grain structure, wall thickness, powder distribution and burning rate are a few of the uncontrollable variables. Terrain, weather, detonation angle and target posture can also be added to the list of factors which made "lethal area" an inprecise measure of casualty-producing potential. ATLAS uses an aggregated firepower score which is called an index of combat effectiveness (ICE).

Research Analysis Corporation (RAC) considered one firepower score per weapon to be sufficient for their use. The Combat Development Command (CDC) used different lethal areas and ammunition consumption rates to derive a set of eleven firepower potentials for each weapon. The variations are intended to reflect different usages and combat postures against different targets. The problem of assigning lethal potential for area-type or point-type weapon systems is further complicated by determining what type of target will be displayed for each system and the degree the target has "hardened" itself against various weapon systems. A man in a hardened posture, for instance a foxhole, cannot be hit by a point-type weapon fired from the same level, however area weapons such as artillery using certain fusing devices might have a potential to injure or kill the soldier in the foxhole.

Any weapon system has zero potential without someone to operate it and the degree of proficiency of system operators could invalidate any preconceived measurement of firepower potential or a system of firepower scores. This variability in crew proficiency or system usage could completely invalidate "average" results utilized in simulated land combat actions.

2. Casualties and Replacements

The discussion of casualties and replacements will be directed toward determining how casualties are produced in simulated war games, and in ATLAS, and then describing the procedure used to replace these casualties during the simulated combat in ATLAS. Since the ability of forces to conduct warfare is in someway related to the production of casualties on enemy units, the capability to degrade the enemy war fighting ability should be

viewed as part of a unit's combat effectiveness. Historical evidence is inconclusive on how closely casualties are associated with combat effectiveness.

One war gaming manual by RAC stated:

> "The reduction in combat effectiveness is not directly proportional to the percentage of casualties. A small percentage of casualties in a fresh, full-TOE unit has, on the average, a negligible effect. A small additional percentage tends quickly to affect the unit's effectiveness." [8]

Casualties play an important part in ATLAS because they determine how the battle is progressing. The combat capabilities of the opposing forces, as expressed by ICE, degrade the force levels of the units proportionately to the respective ICE. In ATLAS casualties are also used to determine the defender's posture when it is not a prepared defense. This is done by assuming that as casualties increase and unit effectiveness decreases, the unit's ability to resist also decreases. Examples of this decrease are observed in the combat postures degenerating from a meeting engagement, to a delaying action, from that to an organized withdrawal, and finally a disorganized retreat. ATLAS does not have a "prisoner of war" capability nor can it account for units being "wiped out."

In summary, the simulation of casualties in a theater level war game like ATLAS provides a method for modifying the assumed basic combat capability of the affected unit. However, the credibility of the modifications rests largely on opinion and belief. Historical records of battles are deficient in quantified and verifiable data and cannot be used to either prove or disprove the assumptions used in war games on casualties.

Regardless of how casualties are produced, ATLAS has a replacement policy to handle this combat function. Initially ATLAS was designed with

a constant percentage of a unit's TOE strength to be used as a replacement rate. With this constant rate policy, individual replacements began entering the battle area on the first day and continued at this constant rate. The linear replacement policy proved to be too inflexible and did not correspond to the actual situation. A non-linear policy was adopted which allowed the replacements to be kept at zero until a specified day, D_1. The form of this replacement curve is as shown in Figure 3.

The replacements start slowly at D_1 and reach a maximum at D_n. Beyond D_n, the maximum rate is in effect. The important result of this policy is that it accounts for units that must continue understrength in the early stages of war when replacements might not be available. A critical assumption which is made in ATLAS however with this non-linear policy is that what is needed is provided.[13] This may not be the case in actual combat due to interdiction of the LOC or other combat activities. Although the non-linear curve appears more realistic, only actual data could support such assumptions and the data is not available.

3. Advance Rate and Associated Factors

Fundamental to the operations in ATLAS is the treatment of the rate of advance of an attacking unit. The speed at which a unit can advance is a function of many variables, some of which may be described explicitly, or, as in ATLAS, handled implicitly. The decision rules which govern the movement of highly aggregated forces have been based on historical data and have generally been accepted by most war gaming authorities. [8] The problem concerning advance rates is that war games, ATLAS in particular, allow continued advance by the attaching force, day after day. This problem has been handled in ATLAS by the introduction of a "holding" posture.

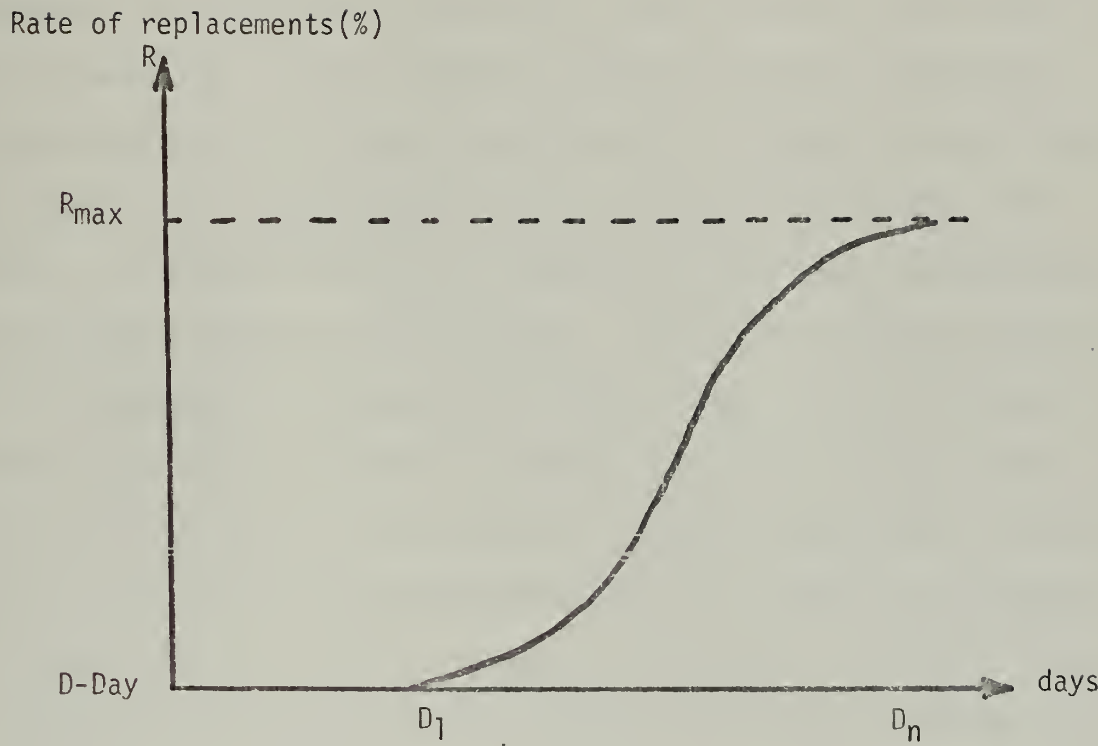

Figure 3: Non-Linear Replacement Curve

The holding posture used arbitrarily when an attack against an enemy in a hasty, prepared, or fortified position has gone on long enough for the attacked to have sustained approximately 10% casualties, a figure that appears to have no empirical basis. However, even with this holding posture, ATLAS might have represented a rate of combat activity that could not be sustained in actual operations due to logistical limitations, human capabilities to sustain such rates, and a change in enemy strategy to counter such a high rate of combat activity. Other factors which affect the attacker's ability to advance are force ratio and the degree of resistence offered by the defender. Force ratios have been discussed in the treatment of firepower measurements. Low force ratios imply both forces about equal and hence a stalemate while higher levels implies the ability of one force to attack against a weaker combat posture. Maneuver, which is recognized as one of the principles of warfare, is not usually simulated in theater level war games, such as ATLAS. A detailed game in a less aggregated form which can be made more dependent upon the opinions and judgments of the players and controllers, would include the possibility of increasing a unit's combat power temporarily to account for some presumed advantage of surprise or maneuver.

There are other factors affecting the outcome of battles that designers are unable to build into their aggregated models with any quantitative basis and thus adding a measure of validity to the models. The most commonly referenced factors are training or readiness, morale, and esprite de corps. The ability to communicate is also a difficult quality to assess, since there is no available data to confirm that the side with more radios is better off. In fact, many argue that after some

unknown level of communication is reached, the addition of more communications is detrimental to combat effectiveness.

It is important to note these specific areas previously discussed affect the validity of ATLAS, hence the entire decision model. The model does not have predictive qualities. Its purpose is to portray what has transpired in ODCSOPS ASOP planning. The validity of the model was discussed in two areas - the author's design and the inputs to that design. A flaw in either would result in an invalid and meaningless model. However, it should be understood that the model was designed without regard for its predictive value but rather for its usefulness as an indicator of past trends and procedures in the force estimating process for the ASOP in ODCSOPS.

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13. ABSTRACT

A model of the ASOP decision process within the Office of the Deputy Chief of Staff for Military Operations is formulated. This decision deals with the aggregated force level estimates for the ASOP. The variables of the model are the informational sources which are utilized in forming the estimate for the ASOP. The Planning, Programming and Budgeting System requires annual submission of the Army's estimate of forces needed to meet strategic objectives. The background for the ASOP estimate is presented. A closer examination of the environment which prevails at ODCSOPS is then examined. The model is then described with a justification for selecting and quantifying the model's variable. A statistical technique was suggested to demonstrate possible insights which could be obtained from the model. The validity of the model is addressed in the concluding portion of the thesis.

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